DIESEL FUEL PARAMETER IMPACTS ON EMISSIONS

COMMENTS OF THE

AMERICAN PETROLEUM INSTITUTE

Presented to:

EPA Diesel Fuel Effects Analysis Workshop

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What is the Ultimate Use/Purpose of the EPA Model?

OVERVIEW

- Model Ramifications
- Model Development Process
- Technical Issues
- Concerns about Statistical Approach and Planned API Analysis
- Summary

Model Ramifications

The EPA Model Could Foster Proliferation of Boutique Fuels

- API supports efforts by states to attain NAAQS.
- HOWEVER - we are concerned that proliferation of boutique gasolines
  - has contributed to market volatility
  - has increased stress on the supply/distribution system.
- We are already engaged with EPA and others on the issue of boutique gasoline fuels.

The EPA Model Could Foster Proliferation of Boutique Fuels (2)

- Issues driving boutique gasoline are also likely to affect diesel.
- Some states have recently shown an interest in regulating diesel fuel properties to fulfill SIPs.
- We are concerned that development of a diesel fuel “Complex Model” will encourage states to adopt area-specific diesel regulations.

Refining and Fuel Distribution System Already Stretched

- Refineries operating at near max rated capacity.
- Major refinery modifications needed to comply with federal requirements for steep sulfur reductions in gasoline and highway diesel fuel.
- Uncertainty in future non-road diesel sulfur requirements also compounds refinery planning and logistical concerns.

Refining and Fuel Distribution System Already Stretched (2)

- Diesel distribution system does not have same flexibility as gasoline distribution system to handle multiple grades of fuel.
- Additional area-specific regulations will
  - further constrain the distribution system
  - limit the ability to respond to unexpected disruptions in supply.

Proposed Model of Little Use in Current Form

- Proposed model is not robust in predicting effects of individual fuel parameters.
  - Could lead to control measures that hurt rather than help.
- Impact of fuels on emerging technology is key for viability of model.
- Only sulfur has been identified as enabling for new technology.

Model Development and Review Process

The EPA Timeline is Too Compressed

- Complex Model for RFG Required ~2 yrs to develop.
- RFG Complex Model involved multiple EPA workshops and close, open collaboration among stakeholders.
- Similar process of peer review and stakeholder input must be followed here.

The August 28 Workshop is a Good Start

- API has retained a statistician to thoroughly review the model and evaluate alternatives.
- He will make some preliminary observations following this presentation.
- More time is needed to do the thorough analysis and assessment required of a model that may significantly impact our industry.
- Detailed written comments will be provided.

Technical Issues

The Database is Extremely Limited

- EPA Draft Diesel Complex Model Developed from a Database of **1,777** emission tests
- This contrasts with databases comprised of
  - **5,446** records for EPA RFG Complex Model
  - **7,724** test records for CARB Predictive Model

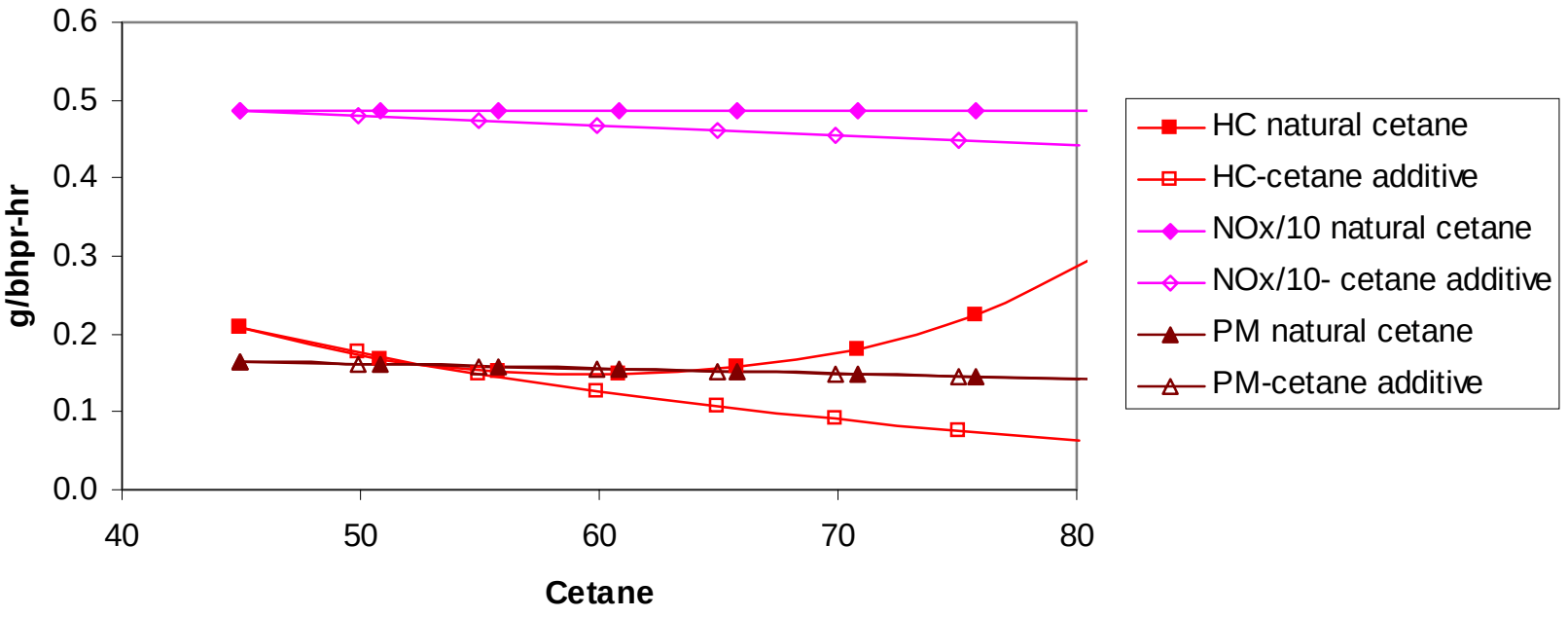
The Database is Extremely Limited(2)

- Underlying database is small and limited with respect to technology groups.
- Only a few diesel fuel parameters have been included in carefully designed studies.
- Except for cetane, experiments have not studied interactive or non-linear fuel property effects.
- Several fuel variables in the EPA models have not been studied in controlled experiments.

Diesel Fuel Property Effects

- Main fuel property effects (cetane, density and aromatics) are included in model
- Predicted impacts of individual properties differ somewhat from those found in well designed studies. Biggest discrepancy is in PM model.
  - Cetane and density effects are overestimated
  - Aromatics and T90 are underestimated
- Differences between natural and additive cetane in model are a concern

Differences Between Additized and Natural Cetane are a Concern



- Many studies have not found the differences between natural and additized cetane in the draft EPA model: VE-1, SAE902172, VE-10, SAE972894, HDEWG
- No theoretical basis for difference
- Model difference probably due to confounding with other fuel variables

Diesel Fuel Property Effects (2)

- Poly-aromatics term should be considered.
  - Some studies have varied poly-aromatics independently. Results from these studies could lead to poor estimation of aromatic effects.
- The modeled Specific Gravity (SG) effects must be further investigated.
  - SG has the largest effect in the Model. SG reduction of 0.05 reduces NOx by 6.7% and PM by 11.2%.
  - But SG is correlated to several diesel properties - aromatics and T10, T50, T90 and cetane.
  - SG reduction results in lighter, lower energy content diesel with fuel economy penalty.

Diesel Fuel Property Effects (3)

- May be better to group engines by emissions level.
  - SAE982649 found smaller fuel impacts in engines with lower emissions.
  - Cetane effects decreasing in newer technology engines.
  - Engine retard for NOx control could have an impact.

Concerns About Statistical Approach Used to Develop the Draft Model and Planned API Analyses

Planned Statistical Investigations (1)

- Forming predictive models from this data base is a stretch of the information available.
  - As we break down the data into various categories, what information is available and how are data confounded?
  - Can the data support addressing key questions statistically?
  - Which questions must rely on engineering or other types of judgement?
  - Can we quantify the value of information in the data base relative to the important questions?

Planned Statistical Investigations (2)

- Predictor terms were included in the model based on various criteria.
  - Some rules about the hierarchy and sequence of predictors were specified. Are they justified and what is their impact?
  - Within the abridged context of statistical variable selection, a forward stepwise procedure was used. Do other valid procedures yield similar results?

Planned Statistical Investigations (3)

- Various evaluations or residuals from the models were described.
  - Additional residual and other diagnostic analyses can be applied. Can we learn any more about the adequacy and appropriateness of the models?

Planned Statistical Investigations (4)

- A version of principal components regression was described.
  - Can an alternative application of principal components help to form better models or provide more information about the draft models?
  - Can other modeling techniques (not OLS or PCR) help to form better models or provide more information about the draft models?

Planned Statistical Investigations (5)

- Several test results were deleted from the data base as designated outliers.
  - Is the deletion of these data justified statistically or otherwise?
  - What is the impact of deleting the observations?

Summary

- Development of a diesel “Complex Model” has serious implications for the fuel supply and distribution system.
- The underlying database is not sufficiently robust to support the statistical models outlined in the draft EPA Technical Report.
- The draft Models are not fully justified based on engineering analysis and the results of well-designed studies.
- API is investigating alternative statistical approaches.

What is the Ultimate Use/Purpose of the EPA Model?